CREATE: Cyanobacteria Research for Enhancing Alabama-based Training and Education

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The energy sciences workforce faces a huge challenge in developing talents from academic institutions that have been historically underrepresented in the DOE research portfolio. The program is a comprehensive training and education program at Alabama State University (ASU), a Historically Black College and University (HBCU), to help address the vast challenge of recruiting the talents from academic institutions that have so far been underrepresented in the DOE research portfolio and support underrepresented students and early career researchers. The project aims to overcome barriers to recruitment and retention of underrepresented minorities with comprehensive training activities in microbiology and energy science. The training is integrated with research activities that focus on developing local resources and exploiting natural genetic variation. It is hypothesized that there exists a diversity of native algae and cyanobacteria in the Alabama and Gulf Coast regions with unique traits that can be useful to produce carbon-neutral fuels and biochemicals and for environmental services. The project proposes to identify native microalgae and cyanobacteria strains with robust inorganic carbon (Ci) uptake capability and seek potential biotech applications. The research activities will train and mentor underrepresented undergraduates and graduate students and postdoctoral researchers.

The project has three objectives. 1) Isolate microalgae and cyanobacteria strains in Alabama and the Gulf Coast region which involves the collection of microalgae and cyanobacteria strains in selected locations in Alabama and Gulf Coast regions, enrichment in liquid culture, isolation of strains using plates, screening by microscopy, and identification by 16S/18S rDNA PCR and DNA sequencing. 2) Measure metabolites secreted in the medium by isolated strains under various culture conditions and employ membrane-inlet mass spectrometry (MIMS) and a newly developed higher-throughput CO_2 monitoring system to monitor the kinetics of Ci uptake and quantitatively measure the Ci fixation and carbon concentrating mechanism (CCM) capabilities of the cells. The team will investigate energy regulation and management in algal strains by monitoring the metabolic end-products in the growth media and whole cells by bioanalytical techniques. Understanding the dynamic energy flows in cyanobacteria and microalgae will guide new strategies to produce biofuels and chemicals by controlling the energy and carbon sink. 3) Innovative teaching by integrating research activities into the curricula at ASU. The team plans to integrate research components into the classroom and teaching laboratories to extend the impact to more students at ASU. Students will take entry-level classes for credits at ASU to learn the literature, background, and methods related to the research project and conduct independent projects or case studies on focused themes in senior-level classes. Students will conduct research as interns at NREL and WUSTL in the summer months and return as advocates to interest other students in research projects. Students will present in the CARE workshop, Annual Research Fronter Symposium, and other professional conferences. The project will have a significant impact on underrepresented students and prepare a competitive and qualified workforce in the fields of energy, environmental science, and other related research careers. It will advance our fundamental knowledge of energy management in cyanobacteria and microalgae and yield potentially novel potential biotech applications.

This research was selected for funding by the Office of Biological and Environmental Research (BER)

Phage Pathways: STEM training to characterize bacterial resistance mechanisms towards phage and contribution to bioenergy production

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The "Phage Pathways" program aims to cultivate a new generation of scientists at the intersection of microbial ecology and renewable energy. A cohort-based approach will be used to support a vibrant community of growing scientists that will collaborate (through workshops and symposia), adopt course-based research (through science pedagogy) and engage in pathway programs (through internships and bootcamps at DOE national labs) to enhance learning and persistence in microbial ecology and renewable energy. The project's scientific objectives include: (1) characterizing bacterial resistance against phages and (2) assessing how these interactions affect methane production, thus influencing bioenergy efficiency. The project's training objectives include: (1) developing and implementing specialized modules in microbiology, genomics, and bioinformatics, (2) promoting interdisciplinary collaboration through internships and bootcamps and (3) disseminating research findings through curriculum, scholarly publications and community engagement. The project's mentoring, recruitment and accountability objectives include: (1) preparing a diverse group of students for careers in bioenergy and environmental sciences; and (2) continuously evaluating and refining educational methods to maximize learning and career preparation. Through a vertical integration of research and education, the project not only contributes to the intellectual growth in phage microbiology but also enhances the practical and analytical skills of participants, preparing them to lead future scientific inquiries and innovations in environmental and bioenergy sciences.

This research was selected for funding by the Office of Biological and Environmental Research (BER)

Resilience to Growing Extreme Natural Hazards: Developing a Northeast Hazards Workforce

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The research proposes a holistic and inclusive research and training program to the Department of Energy's Reaching a New Energy Sciences Workforce initiative (DOE RENEW) to provide students and early career scientists with opportunities to gain in-depth experience in understanding extreme natural hazards and solving the associated and expanding societal challenges caused by these events. The project aims to improve the knowledge of extreme natural hazards by quantifying and understanding the properties of floods, landslides, heatwaves, and multi-hazard impacts in the Greater New York metropolitan area. A synergistic approach that blends Artificial Intelligence and Machine Learning with traditional computational methods will be used to create more robust, scalable, and dynamic climate-informed natural hazard risk management tools for the next generation of energy science workforce. The project intends to prepare and promote well-trained, diverse graduates and postdoctoral scientists who will become part of the next generation in government, industry, and academia. The trainees will gain the skillsets necessary to immediately contribute to ongoing resilience and adaptation projects in a cost and schedule-driven environment and an increasingly AI-driven workplace. The project brings together a team of multidisciplinary researchers, including civil, environmental, and electrical engineering, climate, atmospheric, and ecosystem science, data science, as well as education and workforce training specialists. The team will work together to prepare a hazards-ready workforce in the Greater New York metropolitan area, one of the densest urban regions in the country and home to nearly 25 million people.

This research was selected for funding by the Office of Biological and Environmental Research (BER)